PHOTOMETRY AND BLAZHKO EFFECT IN RR Lyr TYPE STAR DM Cyg

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ABSTRACT. The photometric CCD observations for RR Lyr type star DM Cyg in Astronomical stations near Odessa(Ukraine) and Kolonica(Slovakia) in 2008 and near Odessa in 2009 have been carried out. The light curves in V system were obtained and the frequency Fourier analyse was performed. From Fourier spectra of the light curves 18 frequencies were identified. The weak Blazhko effect was detected.

Key words: Stars: oscillations - stars; variables: RR Lyr - stars: individual: DM Cyg.

1. Introduction

The variability of the star was found by L. P. Tserasskaya in 1928. The star thoroughly was investigated by D. Ya. Martynov, which determined the primary elements of period. V. P. Tsessevich referred this star to type of the stars with suddenly variations of period. Visual observations in 20 century were carried out by Toronjadze, Esh, Martynov, Dombrovskiy, Selivanov, Gur'ev, Satyvaldyev, Born, Sofronevich, Alaniya, Lange, Lysova, Firmanuk, Braude at all, Tsessevich(1966). The period of Blazhko effect (26^d), found by Lysona & Firmanyuk (1980) was not comfirmed (Sodor & Jurcsik 2005).

Now DM Cyg is known as RR Lyr-star type (RRab) with amplitude $10.^m93 - 11.^m99$ (V), has spectr A9-F6 and period $0.^d41986$, Kholopov et al. (1985).

2. Observations

The photometric CCD observations of DM Cyg in Astronomical stations near Odessa and Kolonica in 2008, and near Odessa in 2009 equipped with V filter have been carried out. Two stars were choosen as comparison and check stars (comp=Tycho 2707-01803, check=Tycho 2707-01687). The 48 cm reflector AZT-3 with the f/4.5 Newtonian focus and CCD photometer with CCD chip Sony ICX429ALL, Peltier cooler and 28 cm reflector with Newtonian focus and CCD camera Meade DSI Pro with chip Sony ICX254AL were used respectively. More then 7140 CCD frames were gethered during two years. The reductions of the CCD frames were carried out using the MUNIPACK (*http://integral.sci.muni.cz/cmunipack*) software. The procedures for the aperture photometry are composed of the dark-level and flat-field corrections and determination of the instrumental magnitude and precision. The relative magnitudes of DM Cyg measured to the magnitudes of comparison star (V^T=12.07; 21:20:58 +32:12:59 (2000.0)). The all set of observations are shown in fig.1. The errors on individual data points vary between 0.005 mag to 0.01 mag.

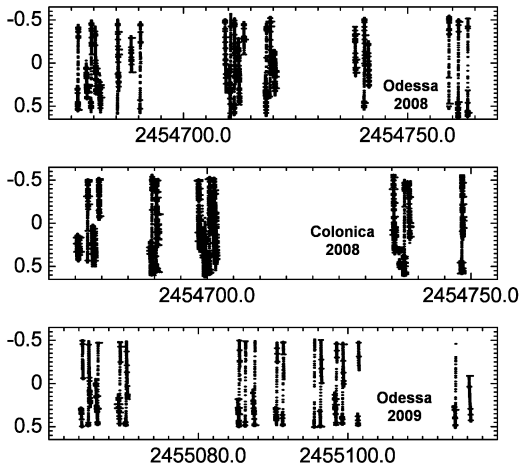

Figure 1: The all data set of observations DM Cyg in 2008-2009.

3. Results

For all observations of DM Cyg were determined the magnitudes comparatively of comparison star. The phase curves were computed from elements:

Max.HJD= $2442582.406 + 0.4198600 \cdot E$, Kholopov et al. (1985).

The light curve shows small amplitude modulations about 0.07 mag and phase modulations up to 0.01. The V light curves DM Cyg and the utmost case of amplitude modulation are shown on fig. 2. These small modulation determine the small Blazhko effect of the star.

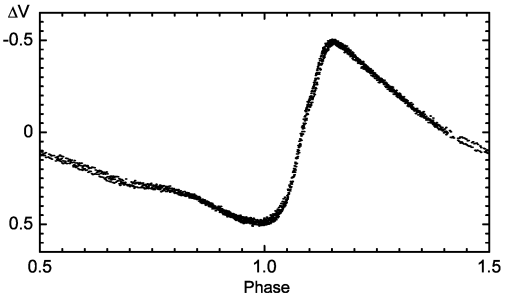

Figure 2: The two utmost case of amplitude modulation in the light curves DM Cyg.

The frequency analyses were performed using a package of computer programs with single-frequency and multiple-frequency techniques by using utilize Fourier as well as multiple-least-squares algorithms (program Period04, Lenz and Breger, 2004). The power spectra of all data set shown in Fig. 3.

The spectrum has been prewhitened for the pulsation component up to f12. Do not all datas were used for frequency analyses. The differences between V instrumental system allow to take only a part data 2008 year and 2009 entirely. The Fourier amplitude and phases of the pulsation component identified in the spectra of the light curves of DM Cyg are presented in Table 1. The basic frequency denoted as f_0, the modulation frequency of Blazhko effect denote as f_B. The errors of the amplitudes are 0.00024, the errors of frequencies and phases are given in table. With increasing order of frequencies the amplitudes of the pulsation are decrease. We find triplet of frequencies $f_0 \pm f_B$, but, perhaps, there are more frequencies in the pulsation spectra of DM Cyg. The amplitude of the component f_0+f_B is larger then the amplitudes f_0-f_B component. This fact have an influence on delay light curve and phase: the maximum of the amplitude modulation precedes the phase of the time delay of the maxima.

From obtained data the frequency of Blazhko effect amount 0.0947 c/d and period $10^d.56$. These values are agree with results, published Jurcsik et al.(2009).

4. Summary

DM Cyg, variable star of RR Lyr type, has pulsations in fundamental mode and small Blazhko effect. The difference of the amplitudes between min and max is about 0.07 mag, Blazhko period about $10^d.56$. The frequency Fourier analyse of light curves shows the components $f_0 \pm f_B$ of spectra up to 9 order.

There are three possible explanation of the Blazhko effect (Kovacs 1995):

- the *oblique pulsator* model, wich assumed that the Blazhko variable have a magnetic field which is oblique to the pulsation axis;

- *dynamical interaction* between the radial fundamental mode and a resonant non-radial mode;

- *steady resonant pulsation* in the radial fundamental mode together with a non-radial mode of low spherical degree with almost the same period. The amplitude modulation is caused by the rotation of the non-radial surface pattern.

The detection small-amplitude light curves modulation of DM Cyg and other RR Lyr stars may confirm the first model (oblique pulsator), so as the magnetic axis has a random distribution in spase, and we could be observe the small and large modulation. But this fact do not contradict to other explanations.

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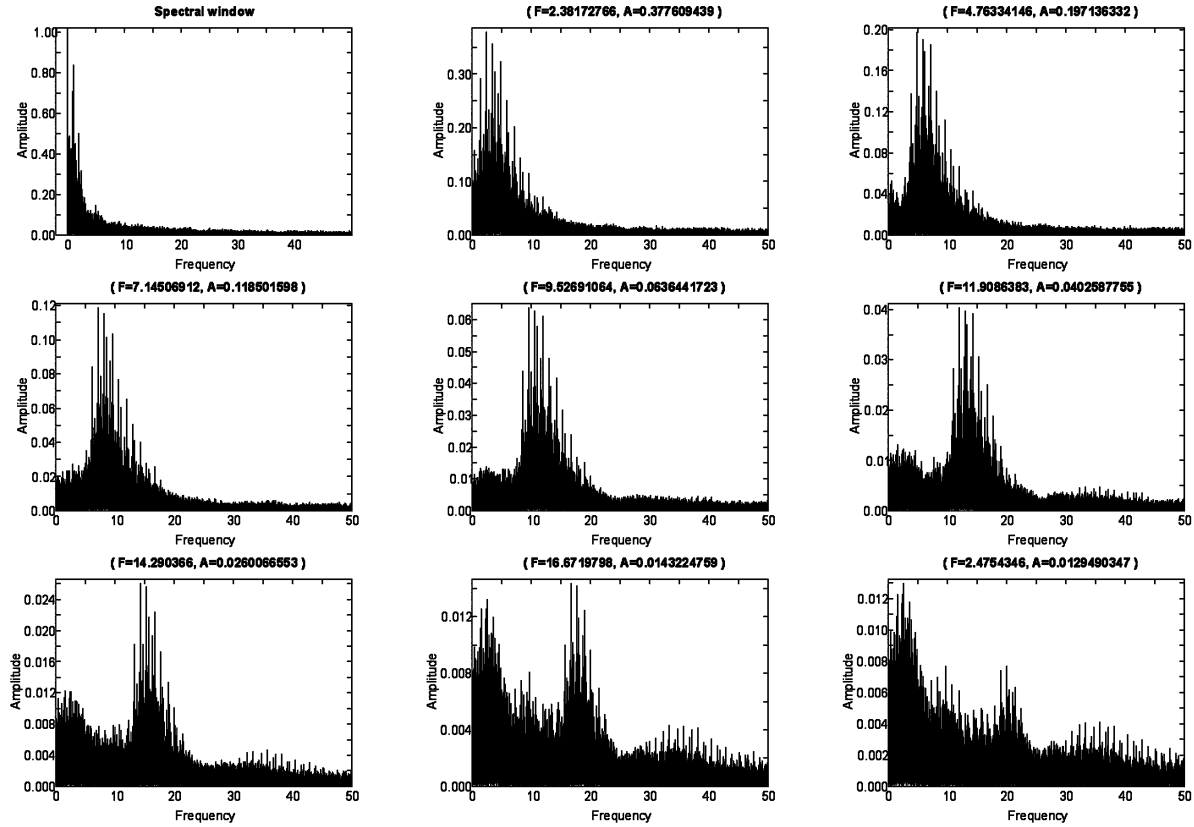

Figure 3: The spectral window and Fourier amplitude spectrum after the removal of the pulsation component (from f1 to f8).

Table 1: Identified Fourier amplitude and phases of the pulsation and modulation frequencies in light curves of DM Cyg.

	Identif.	Frequency	Sigma Fr.	Amplitude	Phase	Sigma Ph.
f1	f_0	2.381670	0.000079	0.335680	0.0837173	0.000114
f2	$2f_0$	4.763475	0.000014	0.181723	0.3182059	0.000212
f3	$3f_0$	7.145023	0.000023	0.1118295	0.2528553	0.000344
f4	$4f_0$	9.526944	0.000044	0.0598717	0.4594258	0.000643
f5	$5f_0$	11.90858	0.000072	0.0366815	0.1547723	0.001051
f6	$6f_0$	14.29043	0.000105	0.0251703	0.6956476	0.001531
f7	$7f_0$	16.67200	0.000188	0.0141136	0.4219310	0.002731
f8	f_0+f_B	2.475495	0.000221	0.0120192	0.7979833	0.003207
f9	$3f_0+f_B$	7.239372	0.000317	0.0083993	0.2286909	0.004590
f10	$8f_0$	19.05422	0.000331	0.00803232	0.8381523	0.004800
f11	$5f_0+f_B$	12.00350	0.000503	0.00529077	0.9015201	0.007287
f12	$7f_0+f_B$	16.76747	0.000566	0.00470369	0.9925396	0.008196
f13	f_0-f_B	2.285704	0.000394	0.00674569	0.2222793	0.005715
f14	$2f_0+f_B$	4.860136	0.000019	0.135926	0.1271544	0.000283
f15	$9f_0$	21.43453	0.000652	0.00408199	0.7569384	0.009445
f16	$4f_0+f_B$	9.617718	0.000641	0.00414875	0.0360648	0.009293
f17	$12f_0$	28.57882	0.001018	0.00261339	0.7852578	0.014753
f18	$9f_0+f_B$	21.53040	0.001006	0.00264637	0.0641502	0.014569